Howick UT

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
TECHNOLOGY UTILIZATION PROGRAM

MANUSCRIPT FOR

AMERICAN MANAGEMENT ASSOCIATION PUBLICATION

By

George J. Howick
Director
Technology Utilization Division

Federally financed research and development is running at around $15 billion a year. New knowledge is being generated in every scientific and engineering discipline. Is it not likely that some of that knowhow is relevant to the needs of your business?

That's a question every manager should be asking himself today. Certainly only a small fraction of the knowledge needed by any company today is being generated in its own laboratories. Most must come from suppliers and other sources.

A source that is too little exploited by most businessmen is the reservoir of new knowledge being continually generated at public expense in defense, space, nuclear energy, and other federal programs.

One reason for the under-utilization of this resource has been the difficulty of gaining easy access to the small portion of this total pool of knowledge that is useful, at any time, to any one organization. Most knowledge, unfortunately, exists in unintelligible forms and in inaccessible places.

That problem is now being attacked by several federal agencies. Among the pioneering efforts is the Technology Utilization Program of the National Aeronautics and Space Administration.

(NASA-TM-89745) NATIONAL AERONAUTICS AND SPACE ADMINISTRATION TECHNOLOGY UTILIZATION PROGRAM (NASA) 23 p

N89-71039

Unclas
00/81 0141469

The Space Act of 1958, which created NASA, charged the Agency with the responsibility to "disseminate as widely as practicable and appropriate the results of its activities." Congress had great foresight in drafting this legislation, recognizing that a primary product of the space agency would be new knowledge.

The NASA Technology Utilization Program has four prime purposes:

. To maximize the return on the public investment in aerospace research and development by bringing about secondary uses for the results of that research and development.

. To shorten the time gap between the discovery of new knowledge and its effective use in a commercial marketplace.

. To move new knowledge across disciplinary, regional, industry, and market lines.

. And, in the process of accomplishing those three purposes, to learn how to transfer technology more efficiently and effectively.

The last purpose is perhaps the most important for the long term. The Technology Utilization Program, like most NASA missions, is experimental in nature. Research and development findings are being brought to the attention of industrial managers via a range of experimental programs. All are aimed at not only encouraging additional uses for new knowledge but also at learning how best to channel that new knowledge from its points of origin to its many points of potential use.

In effect, NASA is attempting to build a new kind of bank--a knowledge bank. The agency is asking those who generate new knowledge to invest it in the bank and encouraging all U. S. citizens to make withdrawals from the bank. Importantly, a form of "interest" is being paid for the withdrawals--for knowledge is a commodity with value. It is a basic resource, just as raw materials or capital.

If we examine patterns of regional economic growth in this country, it is easy to see that for decades the primary source of regional economic growth was natural resources (rivers, mineral deposits, etc.). But more recently, the high growth regions have been those with a great concentration of knowledge (universities, research organizations, corporations working at the leading edge of technology). The same rule applies to corporations and to individuals. The legendary figure to represent today's performance standard would not be a Paul Bunyan who could whack down more trees than anyone else. Instead, he would surely be a man with an exceptional capability to apply new knowledge to the needs of society.

And today's outstanding manager possesses a capability traditionally expected of lawyers and doctors--an understanding of where to turn for critical information. He has plugged his organization into all of the right grapevines. He recognizes that, at a time when national expenditures for research and development are running at an annual rate of around $22 billion his firm can provide, from its own in-house research and development only a fraction of the new knowledge required for continued success in a competitive economy. He realizes that one of the most important determinants of corporate success today is the quality and relevance of information flowing into the corporation from outside.

If we could stand for just a moment high above the stream of history--to view it several decades at a time instead of minute by minute as we do--we would be made dramatically aware of the rapid pace of technological change. For we would see, from our vantage point, that the volume of new knowledge now flowing into that stream is nearly double what it was one short decade ago. We would see that nearly everything that makes up our material world has come about during the last one-tenth of one percent of the time man has lived on this planet. And we would recognize that the pace of change makes it unlikely that the teen-ager of today, when he retires, will buy anything being made today.

For the corporate executive, the implication is clear: The rational acquisition and judicious use of knowledge generated outside his firm will be the most important determinant of the success of his enterprise--and thus his own success as well.

This is the Age of Alternatives. We have more ways to perform a given task than ever before. Choosing the best way in a given situation can have a significant impact on profitability. Take something relatively simple, like putting a hole in a piece of metal. A few years ago, we had only a few choices--drilling, punching, sand casting, perhaps. Today, more than two dozen alternatives exist. For the maker of drilling machines, the competitive implications are severe. His main competition is no longer from other makers of drilling machines. Instead, it's from producers of powder metal parts; from precision metal molding; from plastic injection molding; from producers of electrical discharge and electrochemical machining equipment; from electromagnetics, electrohydraulics and explosives. And tomorrow, he'll have to contend with the laser, the electron beam, the plasma arc, and the ion stream.

For the buyer, it spells the need for more enlightened methods of investment decisionmaking. For the producer, it means he can no longer catalog his competition. For both, it means that the most important determinant of corporate profitability may well be the quality and relevance of information coming into the company from the outside.

And the determination of relevance is no longer an easy task. Increasingly, a new concept developed in one area has its most significant impact in another. And nearly every progressive industry today must draw upon new knowledge developed in dozens of disciplines and hundreds of other industries. Consider the textile industry, for example. It's partly chemical, partly plastic, partly natural fiber, partly paper, partly metals, and a conglomeration of other things. The processing equipment is no longer just mechanical--but electronic, chemical, hydraulic.

Where does one look for the useful new knowledge? The man doing cardiovascular research, for example, has found that the findings of the aerospace fluid dynamicist have great importance to him. And even the relatively small dairy farmer has learned the value of computer time sharing.

The economic impact of technological change is seldom predictable. Every new technical innovation is like a pebble dropped into a pool; the ripples spread out. But today the pebbles are raining into the pool. The ripples are buckling against one another, overlapping on one another, joing forces to become larger ripples, creating by their force and dynamic movement new ripples beneath the surface that break forth and eradicate other ripples while they are still forming.

That's the effect of technology in the marketplace in the second half of the twentieth century.

So the speed with which a corporation can obtain new knowledge and apply it has become increasingly important.

Obviously, there is a need for new knowledge--especially that created at public expense--to be more easily and more rapidly made available to those who can apply it in ways that will enhance economic growth.

The NASA Technology Utilization Program is designing mechanisms for that purpose. Let's take a quick look at them and see how the industrial manager can use them.

To support its own missions--to keep its scientists, engineers, and managers fully abreast of the states of the many arts important to space exploration--NASA has established a sophisticated system to collect on a worldwide basis and to rapidly retrieve useful information. The NASA Scientific and Technical Information Division has collected, since 1962, more than 250,000 documents containing research and development results. These emanate from the Agency's own programs; from those of the Defense Department, Atomic Energy Commission, and other federal agencies; from private sources; from behind the Iron Curtain; from work performed in nearly 40 other countries of the Free World; and from other sources. Each month, another 5,500 documents are added to the storehouse.

All of these documents are abstracted, indexed (with 18,000 index terms), categorized, microfiched, and filed on computer tape.

Additions to the collection are announced semimonthly in two abstract journals. Scientific and Technical Aerospace Reports (STAR) covers worldwide report literature; International Aerospace Abstracts (IAA) indexes articles from scientific journals and technical magazines, books, and meeting papers.

Both are readily available. STAR can be purchased from the Superintendant of Documents, U. S. Government Printing Office, Washington, D. C. 20402, for $33 a year ($42 for foreign subscribers). IAA can be obtained for $25 a year ($33 foreign) from the Technical Information Service, American Institute of Aeronautics and Astronautics, Inc., 750 Third Avenue, New York, New York 10017. Collections of both abstract journals are available at many public, university, and professional society libraries.

In addition to that worldwide collection of information, NASA adds to the nation's knowledge bank in another way. Each NASA contract for research and development contains a clause obligating the contractor to report to NASA all new technology generated in the course of the work under that contract. At each NASA installation, a Technology Utilization Office administers that clause as well as identifying and reporting new technology from NASA in-house work.

Thus the inventions, innovations, improvements, and discoveries resulting from aerospace work are documented and announced. The primary medium for announcement is the Tech Brief. This is a one or two page description of an innovation, sufficiently descriptive to permit the industrial reader to determine whether or not he is interested in it. If he is, he can write to the Technology Utilization Officer whose name appears on the Tech Brief to obtain additional information, such as test data, drawings, photos, and other available information about it. Incremental advances in the state of the art (electronic circuits, tooling tips, mathematical and data processing computer program subroutines, etc.) are grouped and announced in compilations. Especially significant advances are thoroughly documented and published as Technology Utilization Reports, more complete descriptions of the advances.

Any U. S. citizen can be placed on a mailing list to receive such announcements by writing to: Director, Technology Utilization Division, Code UT, NASA, 400 Maryland Avenue, S. W., Washington, D. C. 20546.

As of January 1, 1967, 1,304 Tech Briefs had been issued--700 of them during 1966. More than 1,000 will likely be issued during 1967.

In those technical areas where NASA has made broad and significant advances in the state of the art, NASA contracts for the writing of Technology Surveys. These are guidebooks to the state of the art. Written by authorities in their fields, these Surveys report recent advances, highlighting their significance, then guide the reader to sources of additional information. Among the Surveys published to date are Solid Lubricants; High Velocity Metalworking; Magnetic Tape Recording; Handling Hazardous Materials; Inorganic Coatings; Advanced Valve Technology; and Microelectronics in Space Research. These surveys, as well as most other NASA publications, can be purchased from the Clearinghouse for Federal Scientific and Technical Information, Springfield, Virginia 22151.

A knowledge availability mechanism of special significance to the industrial executive is the experimental Regional Dissemination Center (RDC). Eight of these now exist, all sponsored by NASA. Their purpose is to assist industry in obtaining and using externally-generated knowledge. NASA makes available to these Centers its information system--the computer tapes, microfiche libraries, and technical knowhow. NASA has also provided "seed money" to get the Centers started. Each is obligated to become self-supporting within five years on the basis of industrial fees for services rendered.

The RDC adds value to the basic information by bringing to a member company all the available relevant information and none that is not relevant. The Centers aid their member companies in definition of problems and objectives, in design of search strategies that harvest from the computerized information bank that information which is of value to the company, and in interpretation of the information.

The RDC offers three primary forms of service:

(1) Retrospective searches of the full bank of 250,000 documents in response to specific questions posed by member companies. This is primarily a problem-solving service. For example, an engineer at one member company had difficulty joining a certain kind of ceramic to a certain steel alloy. A retrospective search by the RDC uncovered two research reports that gave the engineer information leading to solution of the problem.

(2) The second principal service is called current awareness. For this, professional personnel of the RDC work with the client company's technical personnel to establish "profiles of interest," i.e., a list of words and phrases that describe areas of continuing technical interest to groups within the company. For example, a design engineering group in a machinery company may want to be kept abreast of all new information relating to vibration resistance techniques and vibration damping materials. A manufacturing engineering group in the same firm may want to be kept updated on all new information related to welding, brazing, and adhesive bonding of ferrous materials. Still a third group may want to know the latest advances of diecasting and forging. Those three groups would each be "profiled" by the RDC and each would, twice monthly, receive a list of abstracts of documents received during that two-week period that are specifically related to those particular interests. Copies of full documents would be provided on request. Further, the RDC would also be able to refer an engineer within any of those groups to persons elsewhere with specific knowledge that might be helpful.

(3) The third basic service is designed to call the member company's attention to areas of opportunity. This service consists of product ideas, process improvement tips, management techniques, and other information that might offer the corporation a lead toward an opportunity--such as a new product, a product improvement, a process improvement, an indication that a change in research priorities should be made, a cost reduction innovation, or a market opportunity.

Although they are new (the first one began in 1963 and the eighth started operations in January 1967), they have already had a significant impact. In January 1967 there were 260 companies paying annual membership fees to the Centers. And additional firms were joining at the rate of four per week. Fees are based on the volume, degree, and comprehensiveness of services desired by member companies. Fees range from less than $500 a year to more than $20,000 a year.

A measure of the effectiveness of the RDC is the fact that more than 9 out of 10 member companies renew their memberships--and many renew for increased rates of service.

The Regional Dissemination Centers are:

. Aerospace Research Applications Center, Indiana University, Bloomington, Indiana.

. Knowledge Availability Systems Center, University of Pittsburgh, Pittsburgh, Pennsylvania.

. Center for Application of Sciences and Technology, Wayne State University, Detroit, Michigan.

. Project ASTRA, Midwest Research Institute, Kansas City, Missouri.

. North Carolina Science and Technology Research Center, Research Triangle Park, Durham County, North Carolina.

. Technology Applications Center, University of New Mexico, Albuquerque, New Mexico.

. Western Research Applications Center, University of Southern California, Los Angeles, California.

. Technology Use Studies Center, Southeastern State College, Durant, Oklahoma.

Each RDC operates somewhat differently from any other and each offers slightly different services. This is partially because the RDC's have an obligation to NASA to conduct research and development into the process of technology transfer while performing their services. The Centers exchange information and advice in a continuing effort to improve their effectiveness.

In late 1966, the NASA Technology Utilization Program added an additional element--a service providing computer programs to industry. In the course of its work, NASA generates many hundreds of computer programs each year. Many of them have broad applicability. They are now being systematically obtained from NASA installations and contractors, abstracted, announced, and made available. The Computer Software Management and Information Center at the University of Georgia, under contract to NASA, sells the program listings, card decks, and tapes at the cost of reproduction and distribution. A number of corporations have saved not only many man-months of effort but hundreds of thousands of dollars by availing themselves of this service. More information is available by writing to: Technology Utilization Office, Marshall Space Flight Center, Huntsville, Alabama. The programs are also available through the Regional Dissemination Centers.

Early in 1966, NASA designed and implemented another kind of knowledge transfer mechanism designed to speed the application of aerospace technology to the fields of medicine and biology. Three Biomedical Application Teams have been established--at Triangle Research Institute, Midwest Research Institute, and Southwest Research Institute. These teams have the task of establishing interinstitutional relationships with groups performing research, development, and engineering in biomedicine (at universities, hospitals, clinics, and related institutions). The team members work with the researchers to pinpoint the barriers that impede the progress of research in the biomedical area within which the research group specializes. These barriers are defined in terms of their component problems--in engineering, the physical sciences, and the life sciences. "Problem Abstracts" are then written and circulated throughout NASA's fourteen installations while retrospective literature searches are conducted. Answers--from the literature and from NASA scientists and engineers--are assimilated by the teams to provide, where possible, a full or partial solution to the problem.

For example, one institution defined a need for a device to detect Parkinson's disease at a very early stage. The Biomedical Application Team hit upon a NASA micrometeorite detector--a crystal so sensitive that a grain of salt dropped on it from one inch will set up an electrical current that can be amplified and read out. The detector has been modified to become a diagnostic tool that shows great potential for early discovery of the existence of the disease.

There are additional ways for the engineer to obtain NASA scientific and technical information. NASA's technical documents and bibliographic tools are deposited at eleven Federal Regional Technical Support Centers. Nearly complete collections are also located at many universities, public libraries and technical society libraries. A complete list is available from the NASA Office of Technology Utilization. NASA documents and bibliographic tools are also available from the Clearinghouse for Federal Scientific and Technical Information, Springfield, Virginia 22151.

In May, the Atomic Energy Commission and NASA began a joint program in technology utilization. Since its inception, the AEC has shared its nuclear knowledge with industry. Offices of Industrial Cooperation have been established at AEC laboratories to steer interested scientists and engineers to sources of useful nuclear knowhow. Now the AEC is also sharing the nonnuclear technology it generates in the source of its missions in a systematic way. Technology Utilization Officers (TUO's) have been appointed at Argonne National Laboratory, Oak Ridge National Laboratory, AEC Headquarters in Germantown, Maryland, and in the Space Nuclear Propulsion Office (a joint effort of AEC and NASA). They identify, document, and report new technology; it is then evaluated, published, and disseminated by the NASA Technology Utilization Program.

The new Office of State Technical Services in the Commerce Department has a charter to assist the states in transferring new knowledge to organizations within the states. This work is, at this early date, being carried forward largely through seminars, conferences, workshops, referral services, and specific assistance on problems that affect an entire industry with a state or region. The Regional Dissemination Centers, sponsored by NASA, have been designated as regional information resources for these groups.

A program is underway between the Vocational Rehabilitation Administration and NASA to apply aerospace technology to the missions of VRA. Areas include prosthetic devices, training aids, and diagnostic tools.

As an example, an unmanned instrument carrier developed by a company for a proposal to NASA was designed to literally walk across the surface of the moon and send back data. The walking principle of the device was conceived by a TUO to serve a different purpose: A wheelchair without wheels. The walking chair has been developed and is being tested. It will negotiate a curb, move across a sandy beach or gravel drive, and walk across other difficult terrain. Battery-powered, it can be controlled by a chin strap, permitting a paraplegic to operate it.

Other interagency programs include a joint effort with the Office of Law Enforcement Assistance (Justice Department) in which space technology is being applied to problems of law enforcement and crime prevention. Areas of interest range from systems engineering and systems management concepts to specific products such as highly reliable batteries.

The NASA Technology Utilization Program continues to experiment with other means of disseminating, communicating, and encouraging movement of new knowledge from its many points of origin to its many other points of use.

The groundwork is being laid for a national network of information communication systems that someday, hopefully, will permit any U. S. citizen, with a need, to obtain rapid and easy access to the results of the work performed by any engineer or scientist under government auspices. Perhaps the engineer will need to only walk across the room to a cathode ray tube surrounded by toggle switches to be put in touch with the documented results of other engineers' work or even the other engineers themselves. (NASA is presently experimenting, on a pilot basis, with a time-shared computer system that permits the individual to search the NASA scientific and technical information storehouse, designing his search strategy as he goes. The system even has a programmed instruction mode so that the machine can tell the user how to operate the system.)

But before any such system can really be successful, engineers and scientists must adopt a broader philosophy. If you want to transfer technology, you must have technology to transfer. Those who generate new knowledge must, therefore, begin to share the responsibility for documenting and communicating that new knowledge. They must recognize that knowledge is not provincial; only people are. They must learn that the problem they solved to render workable the device they are now designing is not limited to that device; the solution may be very useful to another engineer working in another context.

Only a small amount of new technology lends itself to transfer in the form of a discrete device. More important is the communication of the concepts and principles underlying that device, innovation, invention, or other form of knowledge. From those concepts and principles, other ingenious men can build analogs of the hardware for which those concepts were originally generated.

The real test of the worth of the NASA Technology Utilization Program, therefore, has yet to be made. That test is to determine whether the program can bring about some changes in habits--whether the program will lead to innovative men documenting and communicating their hard-won knowledge for the use of others. That is what NASA is attempting to do--to insure that the knowledge earned in the course of its complex missions will find its way into the mainstream of the U. S. economy for the benefit of all those whose taxes have made possible the conquest of space.

For additional information on the NASA Technology Utilization Program, or any aspect of it, write to: Director, Technology Utilization Division, NASA, Code UT, 400 Maryland Avenue, S. W., Washington, D. C. 20546.

Following are a few examples of ways that organizations have applied aerospace knowledge for other purposes. These cases typify the hundreds of similar cases that have taken place.

Walking Chair

For a proposal to NASA, a company designed an unmanned instrument carrier intended to literally walk across the surface of the moon, gathering data. A NASA Technology Utilization Officer saw the opportunity to adapt the walking principle to a completely different use--a wheel-less wheelchair. Through the cooperation of the Department of Health, Education, and Welfare, Space-General Corporation, and NASA, prototype walking chairs have been built and are being tested at rehabilitation centers.

Sight Switch

An astronaut, under high forces of gravity, faced the possibility of not being able to move his hands and legs. So a sight switch was developed for NASA that would permit the astronaut to actuate controls by simply moving his eyes from side to side. The switch operates on the principle of differential reflectivity between the white and iris of the eye. In the "off" position, a ray of light is transmitted (from the switch mounted on eyeglass frames) to the white of the eye, and reflected back to the sensor. The wearer, by moving his eye, can place the iris in the path of the light ray. It absorbs more light and reflects less to the sensor, thus actuating a switch. This unit has been adopted for the use of paralyzed patients to raise and lower hospital beds, call nurses, and even communicate--via relays and a lighted message board. It has also been applied to the control of a motorized wheelchair. Other contemplated uses include telephone dialing, control of industrial devices, and operation of a stenotyper.

Lubricated Bearings

Knowledge gained by NASA in the development of a ceramic-bonded dry lubricant for use in a propellant pump has been the basis for development, by a bearings manufacturer, of a line of bearings coated with the dry lubricant that have long life, maintenance free.

X-Ray Enhancement

Computerized techniques, developed for NASA use in sharpening Mariner photographs have been applied to "cleaning up" X-Ray negatives. While the X-Ray enhancement technique has not yet been fully perfected, it shows great promise for standard medical diagnostic use.

Peel Tester

A NASA-developed device to accurately measure peel strength of laminates has been adopted by five different corporations for five different uses. A major metal producer is using an adaptation of it routinely in testing of composite materials. A large lumber firm has used the basic principles to build a device to test peel strength of aluminum-plywood laminates. An eastern firm is using the device to test adhesive bonds. An instrument maker is using it to test peel strength of composition boards.

Magnetometer

A magnetometer developed by NASA is presently being modified by a Massachusetts firm to make it easier to manufacture. The firm foresees a market for the device of around 30,000 units a year.

Coaxial Cable Cutter and Stripper

A California firm is making and selling, under a license, a tool to cut and strip coaxial cable that was developed by NASA. At a unit price of $39.95, sales exceeded $100,000 by August 1966, and the item is the most profitable in the company's product line.

Inorganic Paint

For thermal control of spacecraft, NASA developed a silicate-based inorganic coating. The paint features a set of unique properties including good abrasion resistance, exceptional resistance to chemical attack, extremely good heat resistance, thermal shock resistance, and color-fastness. NASA had, as of January 1967, granted 22 nonexclusive, royalty-free licenses to companies to make and market the paint. In addition, several hundred other companies have sought additional information about the paint. At least 97 companies have some type of active interest in it. Seven are conducting in-house programs aimed at commercial manufacture and sale of the paint.

Hydraulic Fluid

A new product line is resulting from the services of a Regional Dissemination Center to one of its member companies. The Center provided information showing the potentiality of partial alkyl ester, alkali salts of phosphates and phosphonates as candidates for pour point depressants for fire resistant water based hydraulic fluids. The firm expects to make and market the line.

Printing Press Safety

A client company of an RDC mentioned a need for shock absorption in its printing presses. The RDC provided information on a special kind of frangible tube shock absorber that proved useful and the firm has modified its equipment to incorporate the design.

Stiffened Bends

A producer of steel structures sought information from an RDC on the structural characteristics of thin wall cylinders in the hope of obtaining improved design concepts and data leading to better fabrication methods for safer steel buildings. A computer search retrieved 375 articles of which 81 proved of direct utility in the company's problem area. The firm used the information to come up with a new series of designs for stiffened bends. The firm estimates that this one assist from the RDC alone saved it $35,000 worth of research and development effort.

Geophysical Exploration

An RDC client in the mineral prospecting field has used Gemini photos as an adjunct to geological exploration. The photos have been found by this company to be superior for its purposes to the usual aerial mosaics. In several cases, it has been possible to delineate local as well as regional features; topographic lineaments and structural relationships can be traced over considerable distances.

Concrete Replacement

A producer of boat houses and boat decks obtained RDC assistance to try to solve a problem of concrete-styrofoam walkways breaking in transit. Information on methods of coating wood with plastic was pinpointed by the RDC and the resulting process change is expected to lead not only to solution of the breakage problem but to an improvement in efficiency that will permit reduction of the labor force by eight men.